CLAIMS

What is being claimed is:

1. A III-nitride light emitting device comprising:

a first layer of first conductivity type;

a first layer of second conductivity type;

an active region;

a tunnel junction, the tunnel junction comprising:

a second layer of first conductivity type having a dopant concentration greater than the first layer of first conductivity type; and

a second layer of second conductivity type having a dopant concentration greater than the first layer of second conductivity type;

a third layer of first conductivity type;

a first contact electrically connected to the first layer of first conductivity type; and

a second contact electrically connected to the third layer of first conductivity type;

wherein:

the first and second contacts comprise the same material;

the first and second contact material has a reflectivity to light emitted by the active region greater than 75%;

the active region is disposed between a layer of first conductivity type and a layer of second conductivity type; and

the tunnel junction is disposed between the first layer of first conductivity type and the third layer of first conductivity type.

2. The device of claim 1 wherein:

the second layer of first conductivity type has a dopant concentration ranging from about $10^{18}cm^{-3}$ to about $5x10^{20}cm^{-3}$; and

the second layer of second conductivity type has a dopant concentration ranging from about $10^{18}cm^{-3}$ to about $5x10^{20}cm^{-3}$.

3. The device of claim 1 wherein the second layer of first conductivity type has a dopant concentration ranging from about $2x10^{20}cm^{-3}$ to about $4x10^{20}cm^{-3}$.

4. The device of claim 1 wherein the second layer of second conductivity type has a dopant concentration ranging from about $7x10^{19}cm^{-3}$ to about $9x10^{19}cm^{-3}$.

5. The device of claim 1 wherein the tunnel junction has a voltage drop ranging from between about 0V to about 1V when operated in reverse-biased mode.

6. The device of claim 1 wherein the tunnel junction has a voltage drop ranging from between about 0.1V to about 1V when operated in reverse-biased mode.

7. The device of claim 1 wherein:

the second layer of first conductivity type has a thickness ranging from about 1 nm to about 50 nm; and

the second layer of second conductivity type has a thickness ranging from about 1 nm to about 50 nm.

8. The device of claim 1 wherein the tunnel junction has a thickness ranging from about 2 nm to about 100 nm.

9. The device of claim 1 further comprising a textured layer disposed between the third layer of first conductivity type and the second contact.

10. The device of claim 9 wherein the textured layer comprises islands of semiconductor material and pockets between the islands.

11. The device of claim 10 wherein the islands of semiconductor material comprise about 10% to about 90% of a volume of the textured layer.

12. The device of claim 10 wherein the islands of semiconductor material comprise about 10% to about 50% of a volume of the textured layer.

13. The device of claim 10 wherein the pockets are filled with air.

14. The device of claim 10 wherein the pockets are at least partially filled with a material having an index of refraction less than about 2.

15. The device of claim 10 wherein the second contact is formed over the textured layer and fills the pockets.

16. The device of claim 9 wherein the textured layer has a thickness between about 200 Å and about 10,000 Å.

17. The device of claim 9 wherein the textured layer has a thickness between about 500 Å and about 4000Å.

18. The device of claim 9 wherein the second contact is bonded to the textured layer.

19. The device of claim 18 further comprising at least one void disposed between the textured layer and the second contact.

20. The device of claim 1 further comprising:

a submount;

a first interconnect connecting the first contact to the submount; and

a second interconnect connecting the second contact to the submount.

21. The device of claim 20 further comprising:

a plurality of leads connected to the submount; and

a lens overlying the submount.

22. The device of claim 21 further comprising:

a heat sink disposed between the leads and the submount.

23. The device of claim 1 wherein the first and second contacts comprise aluminum.

24. The device of claim 1 wherein at least one of the first and second contacts comprises a multilayer contact.

25. The device of claim 24 wherein the multilayer contact comprises a first layer of aluminum and a second layer overlying the first layer, the second layer comprising a material selected from a group consisting of Al-Si, Al-Si-Ti, Al-Cu, and Al-Cu-W.

26. A III-nitride light emitting device comprising:

a first layer of first conductivity type;

a first layer of second conductivity type;

an active region;

a tunnel junction, the tunnel junction comprising:

a second layer of first conductivity type having a dopant concentration greater than the first layer of first conductivity type; and

a second layer of second conductivity type having a dopant concentration greater than the first layer of second conductivity type; and

a textured layer overlying the tunnel junction;

wherein the active region is disposed between a layer of first conductivity type and a layer of second conductivity type.

27. The device of claim 26 further comprising:

a first contact electrically connected to the first layer of first conductivity type; and

a second contact electrically connected to the textured layer.

28. The device of claim 27 wherein a surface of the second contact adjacent to the textured layer is substantially flat, the device further comprising at least one void disposed between the textured layer and the second contact.

29. The device of claim 28 wherein the void is filled with air.

30. The device of claim 26 further comprising a polarization selection layer.

31. The device of claim 30 further comprising a substrate having a first surface and a second surface opposite the first surface, wherein the first layer of first conductivity type overlies the first surface and the polarization selection layer is disposed on the second surface.

32. The device of claim 30 wherein the polarization selection layer comprises a wire grid polarizer.

33. The device of claim 26 further comprising:

a submount;

a first interconnect connecting the first contact to the submount; and

a second interconnect connecting the second contact to the submount.

34. The device of claim 33 further comprising:

a plurality of leads connected to the submount; and

a lens overlying the submount.

35. The device of claim 34 further comprising:

a heat sink disposed between the leads and the submount.

36. The device of claim 26 wherein the textured layer comprises islands of semiconductor material and pockets.

37. The device of claim 36 wherein the islands of semiconductor material comprise about 10% to about 90% of a volume of the textured layer.

38. The device of claim 36 wherein the islands of semiconductor material comprise about 10% to about 50% of a volume of the textured layer.

39. The device of claim 36 wherein the pockets are filled with air.

40. The device of claim 36 wherein the pockets are at least partially filled with a material having an index of refraction less than about 2.

41. The device of claim 36 wherein the second contact is formed over the textured layer and fills the pockets.

42. The device of claim 26 wherein the textured layer has a thickness between about 200 Å and about 10,000 Å.

43. The device of claim 26 wherein the textured layer has a thickness between about 500 Å and about 4000Å.

44. A III-nitride light emitting device comprising:

a substrate having a first surface and a second surface opposite the first surface;

a layer of first conductivity type formed on the first surface;

a layer of second conductivity type;

an active region disposed between the layer of first conductivity type and the layer of second conductivity type; and

a textured layer formed on the second surface.

45. The device of claim 44 wherein the substrate is SiC.

46. The device of claim 44 wherein the textured layer comprises islands of semiconductor material and pockets.

47. The device of claim 46 wherein the islands of semiconductor material comprise about 10% to about 90% of a volume of the textured layer.

48. The device of claim 46 wherein the islands of semiconductor material comprise about 10% to about 50% of a volume of the textured layer.

49. The device of claim 44 wherein the textured layer has a thickness between about 200 Å and about 10,000 Å.

50. The device of claim 44 wherein the textured layer has a thickness between about 500 Å and about 4000Å.